Automated Manufacturing of Composite Isogrid Structures Utilizing Foam Mandrels

Project Number: 95-08

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Purpose

The purpose of this study is to investigate the fabrication of composite isogrid structures utilizing a structural foam mandrel. All design, analysis, and fabrication will be performed using existing Marshall Center facilities. The study will concentrate on the use of a structural foam mandrel, developed at MSFC, which will provide a low-cost, easy to fabricate tool on which to build the isogrid pattern. Initial composite structures fabricated will be 5.75 inches in diameter. The information they yield during testing will then be applied to enhance the composite part quality for the next set of isogrid structures which will be 18 inches in diameter.

Background

Today's commercial and aerospace industries are placing greater demands on the materials they use. Products are often expected to perform at higher loads, withstand more extreme environments, weigh less, and cost less to produce. Because of their unique properties, fiber/matrix composites have allowed industry to achieve a greater performance from its product. Properties such as high stiffness-to-weight ratios, low coefficient of thermal expansion, and high corrosion resistance have made fiber/matrix composites especially attractive to the aerospace industry where weight, high strength, and thermal stability are performance drivers. This experiment will investigate the fabrication of composite isogrid structures, which may be utilized on future flight vehicles.

Approach

To properly evaluate composite isogrid structures fabricated using foam tooling, the following approach was developed:

1. Design the isogrid pattern and specimen sizes, based on expected performance and processing concerns;

2. Fabricate the foam mandrels, and machine in the grid patterns based on the design. After mandrels are ready filament wind composite structures on mandrels and cure;

3. Conduct structural testing on fabricated isogrid samples to determine integrity of isogrid pattern;

4. Re-evaluation of isogrid design based on gathered data, and fabrication of additional sample incorporating any changes. Testing of additional samples should also be completed; and

5. Fabricate second generation foam mandrels and isogrid structures, scaling the size up to a larger diameter, and looking at the possibility of winding isogrid dome structures.

Accomplishments

During the past year filament winding of two mandrels was done to identify and address processing concerns.

Planned Future Work

- Complete filament winding of 5.75 inch diameter isogrid cylinders;
- Conduct structural tests on samples, tensile, compression, shear, etc.;
- Evaluate results and make assessment on processing changes to improve part quality;
- Begin fabrication of second generation 5.75-inch-diameter isogrid cylinders, with processing improvements; and
- Scale up processing for fabrication of 18-inch-diameter cylindrical.

Funding Summary ($k)

	FY95	FY96	FY97	FY98
Approved funds:	80	50	0	0
Expended funds:	80	50	0	0

Total project cost of 130k

Status of Investigation

Project approved—September 28, 1994

New projected completion—September 28, 1998